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(54) **Apparatus for enhanced emboss bonding of multi-ply tissue products and tissue products obtainable with the apparatus.**

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Description

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to the apparatus and method for emboss bonding multi-ply tissue products and to the resultant product.

Description of Related Art

It is well-known to emboss bond multiple plies of lightweight cellulosic material to form tissue products such as napkins. The use of emboss bonding of the periphery of such products not only secures the multiple plies together but also provides a decorative pattern frequently referred to as "coin edge." Examples of apparatus and methods for emboss bonding multi-ply paper products are disclosed in Nystrand, U.S. Patent Nos. 3,867,872 and 3,834,286; Asmuth, U.S. Patent No. 3,580,797; Palmer et al., U.S. Patent No. 3,323,983; Walton, U.S. Patent No. 2,729,267; and Jopson, U.S. Patent No. 1,929,924.

The subject invention improves upon known emboss bonding apparatus and methods by providing emboss bond having traditional coin edge emboss appearance with improved bonding strength.

Additional advantages of the invention are set forth in part in the description which follows, and in part will be obvious from the description, or may be learned by practice of the invention.

SUMMARY OF THE INVENTION

The objects and advantages of the invention may be realised and obtained by means of the instrumentalities and combinations particularly pointed out in the appended claims.

In accordance with the invention as broadly described herein, there is provided an apparatus for emboss bonding two or more lightweight cellulosic webs to form a multi-ply article, the apparatus comprising:

a pair of rolls disposed for cooperative rotation about parallel cross machine axes and defining a nip between the surfaces thereof; and

means on the cooperating surfaces of said rolls for forming on webs introduced into said nip an emboss pattern comprising a plurality of truncated right rectangular pyramids projecting from one surface of said webs in aligned adjacent relationship in the machine direction (MD) and the cross machine direction (CD), the forming means on one of the said rolls comprising a plurality of truncated right rectangular pyramidal cavities in said roll surface, each said cavity being defined by an axis coaxial with a radius of one of said rolls, a base defining an opening in the surface of said one roll, a generally planar apex axially spaced from said base and generally perpendicular to said axis, and sidewalls extending between said base and said apex, the sidewalls diverging from said apex at an angle to said axis in the range of about 25° to about 40°.

Preferably one roll has a metal surface and the forming means comprises an etched area on the surface of the one roll having predetermined dimensions and comprising a plurality of truncated right rectangular pyramidal cavities in said roll surface disposed in adjacent CD and MD relationships.

In one preferred embodiment the other roll has an impressionable surface capable of conforming under pressure to the etched area.

In another preferred embodiment the other roll has a metal surface including a cooperating etched area having the predetermined dimensions, the cooperating etched area comprising a plurality of truncated right rectangular pyramids projecting from the surface of the other roll for meshing engagement wish the cavities in the surface of the one roll.

Preferably, each cavity in the surface of the one roll is defined by an axis coaxial with a radius of the roll, a base defining an opening in the surface of the roll, a generally planar apex axially spaced from the base and generally perpendicular to the axis, and sidewalls extending between the base and the apex, the apex having a CD dimension in the range of about 0.635 mm (.025") to about 1.27 mm (.050"), a MD dimension in the range of about 0.508 mm (.020") to about 1.27 mm (.050") and a MD/CD dimension ratio of at least about 2/3, the axial distance between the base and the apex being in the range of about 0.254 mm (.010") to about 0.305 mm (.012"), and the sidewalls diverging from the apex at an angle to the axis in the range of about 25° to about 40°.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate embodiments of the invention, and, together with the description, serve to explain the principles of the invention.

Figure 1 is a perspective view of an embodiment of the apparatus in accordance with the invention.

Figure 2 is an enlarged, non-scale cross-sectional schematic view of one cavity of the emboss pattern of the apparatus of Figure 1 and its relationship to the other roll prior to application of pres-

sure.

Figure 3 is a perspective view of another embodiment of the apparatus in accordance with the invention.

Figure 4 is an enlarged, non-scale cross-sectional schematic view of one cavity of the emboss pattern of the apparatus of Figure 3 and its relationship to the mating pyramid projecting from other roll prior to application of pressure.

Figure 5 is a plan view of one cavity of the emboss pattern of the invention.

Figure 6 is a plan view of four cavities of the emboss pattern of the invention.

Figure 7 is a schematic cross-sectional view depicting the dimensions of a cavity of the emboss pattern of the invention in the cross machine direction.

Figure 8 is a schematic cross-sectional view depicting the dimensions of a cavity of the emboss pattern of the invention in the machine direction.

Figure 9 is a schematic cross-sectional view of one cavity of the emboss pattern of the invention in mating relation with the imposed impressionable surface.

Figure 10 is a plan view of one embodiment of the product manufactured using the apparatus of the invention.

Figure 11 is a cross-sectional perspective view of one impression in the emboss pattern of the product of Figure 10 formed using the apparatus of the invention.

Figures 12, 13, 14, 15 and 16 are graphic represention comparing the strength of the bond formed in accordance with the invention with bonds formed using other emboss patterns.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Reference will now be made in detail of the present preferred embodiments of the invention, examples of which are illustrated in the accompanying drawings.

In accordance with the invention, as embodied and broadly described herein, an apparatus for emboss bonding two or more lightweight cellulosic webs to form a multi-ply article comprises a pair of rolls disposed for cooperative rotation about parallel cross machine axes and defining a nip between the surfaces thereof.

As depicted in Figures 1 and 3, the apparatus comprises first roll 20 and second roll 60 disposed for cooperative rotation about parallel cross machine axes 24, 61 and defining a nip 62 between the surfaces of rolls 20, 60.

In accordance with the invention, the apparatus includes means on the cooperating surfaces of the rolls for forming on webs introduced into the nip an embossed pattern comprising a plurality of truncated right rectangular pyramids projecting from one surface of the webs in aligned adjacent relationship in the machine direction (MD) and the cross machine direction (CD).

In the preferred embodiments depicted in Figures 1 and 3, first roll 20 has a metal surface 22 and the forming means comprises an etched area 26 in the surface of first roll 20. Etched area 26 has predetermined dimensions selected to define an embossed bond pattern on an article formed from webs 64 introduced into nip 62. Etched area 26 comprises a plurality of truncated right rectangular pyramidal cavities 28 in surface 22 of roll 20, the cavities being disposed in adjacent relationship in the MD and CD directions.

Preferably, as depicted in Figures 2 and 5-8, cavities 28 are immediately adjacent each other in the cross machine and machine directions defining essentially a knife edge between the cavities. While this is believed to be ideal, certain factors may require spacing between adjacent cavities depending upon the web being emboss bonded, the required pressure of emboss bonding and other production factors affecting the ability to efficiently manufacture multi-ply articles without unacceptable damage such as excessive cutting of webs 64 or cutting of the surface of the opposed roll. To avoid these problems some spacing between adjacent cavities on the order of about .003" to about .006" may be necessary. Additionally, spacing between adjacent cavities may be imposed due to limitations on engraving technology.

Preferably each cavity 28 is defined by an axis 30 coaxial with a radius of first roll 20, a base 32 defining an opening in surface 22 of first roll 20, a generally planar apex 34 axially spaced from base 32 and generally perpendicular to axis 30, and sidewalls 36, 38 extending between base 32 and apex 34. Preferably, apex 34 has a cross machine direction (CD) dimension 40 in the range of about 0.635 mm (.025") to about 1.27 mm (.050") a machine direction (MD) dimension 42 in the range of about 0.508 mm (.020") to about 1.27 mm (.050") and a MD/CD dimension ratio of at least about 2/3. Preferably, the axial distance 44 between base 32 and apex 34 is in the range of about 0.254 mm (.010") to about 0.305 mm (.012"), the axial distance 44 in the machine direction being in fact slightly less than in the cross machine direction since roll surface 22 curves in the machine direction. Sidewalls 36, 38 preferably diverged from apex 34 at an angle 46, 48 to axis 30 in the range of about 25 degrees to about 40 degrees.

The shape and dimensions of cavities 28 are selected to generate greater bonding pressure in the emboss bond area for a given pressure between the surface of the first roll and a co-operat-

ing roll. This is achieved by having sidewalls at a relatively steep angle which generates greater pressure in the sidewall portions of the impressions formed in the emboss bonding area. Moreover, the relatively small size of each cavity permits a greater number of such cavities per given area of bond resulting in a greater bond area. The relatively short distance between the apex and base of the cavity reduces stretching of the web as it is deformed into the cavity.

In a preferred embodiment, each cavity has an apex having a CD dimension 40 of about 0.686 mm (.027") and an MD dimension 42 of about 0.508 mm (.02"), an axial distance 44 between apex 34 and base 32 of about 0.305 mm (.012"), an angle 46 between axis 30 and cross machine direction walls 36 of about 40 degrees, and an angle 48 between axis 30 and machine direction walls 38 of about 25 degrees.

Since increasing the number of cavities 28 in etched area 26 increases the bonding area for a given emboss area, preferably the combined area of the apices 34 or cavities 28 is at least about 30% of the total area of etched area 26 which is also the area of the emboss bond imposed on the multi-ply article.

The pattern of etched area 26 is generally selected to define an emboss bond proximate the perimeter of the multi-ply article and the total area of the emboss bond determines the strength of the bond with respect to any particular article. Accordingly, the area of the emboss bond in a particular article is predetermined based upon the size of the article and the number and weight of the cellulosic webs forming the article. Preferably, therefore, the area of etch pattern 26 which forms the emboss bond is at least about 9677.4 mm^2 (15 square inches) per gram of article weight.

In a preferred embodiment, the etched area defines a rectangle having two parallel sides extending circumferentially on surface 22 of first roll 20 and two parallel sides extending on surface 22 of first roll 20 in the cross machine direction.

While various placements and aesthetic dispositions of the emboss bond may be used in any multi-ply article, in a preferred embodiment, etched area 26 is disposed to form an emboss bond extending from the edge of an article a width in the range of about 6.35 mm (.25") to about 38.1 mm (1.5"). It may be preferred, as depicted in Figure 10, for article 50 to have an emboss bond area comprising two parallel patterns 52, 54 having a space 56 therebetween of about 6.35 mm (.25"). Naturally, to achieve such an emboss bond, pattern of cavities in etched area 26 would correspond.

In one preferred embodiment of the apparatus, depicted in Figures 1 and 2, second roll 60 has an impressionable surface 66 capable of conforming under pressure to the etched area.

In operation, the first embodiment, as depicted in Figure 9, pressure generated at nip 62 between rolls 20 and 60 will cause the impressionable surface 66 of roll 60 to deform and fill cavities 28 in the surface 22 of roll 20. The deformation of surface 66 of roll 60 will press webs 64 into cavity 28 creating an impression in the resulting multi-ply article. The impressions 70 (Fig. 11) in article 50, a plurality of which define the emboss area of article 50, generally conform to the size and shape of cavities 28.

In an alternative embodiment, depicted in Figures 3 and 4, second roll 63 has a metal surface 67 including a cooperating etched area 69 having substantially the same predetermined dimensions as etched area 26. Cooperating etched area 69 comprises a plurality of truncated right rectangular pyramids 71 projecting from surface 67 of roll 63 for meshing engagement with cavities 28 in surface 22 of first roll 20. The shape and dimensions of pyramids 71 correspond to the cavities to which they are to mesh. Thus, the description above with respect to Figures 5-8 apply as well to pyramids 71, except of course that the apices of the pyramids are spaced radially outwardly from the roll surface and the bases of the pyramids are not holes in the surface of the roll. The bases of the pyramids 71 preferably form an inverted knife edge.

The advantages of the invention over apparatus incorporating known embossing patterns are demonstrated by the graphs in Figures 12-15. The graphs represent tests performed comparing the etched pattern of the subject invention (pattern # 8204) against commercially available coin edge patterns and some other prototype test patterns. All tests were performed by pressing 2 ply, 17.9 gm^2 (11 lb./3000 $ft.^2$) basis weight cellulosic material between a hardened steel engraving of the pattern and a conventional fiber filled roll. All tests were run at a pressure of 3571.6 kg/m (200 lbs. of force per linear inch) of pattern width in the cross machine direction.

Figure 12 represents the results of tests of the pattern of the invention (# 8204) against 6 hardened steel engravings of patterns of commonly employed coin edge emboss bonds. The experiment was conducted by mechanically pressing each hardened steel engraving into a conventional fiber filled roll, the same fiber filled roll was used for each pattern to maintain consistent conditions. In each case the engraving was female, that is, the etched area comprised cavities. Ten samples of the 2-ply napkin stock were passed through the nip of each coin edge emboss pattern. Although every attempt was made to maintain a constant nip pressure for each of the patterns, pressure sensitive

film was also used to measure the actual pressure applied to each of the emboss patterns evaluated. The ply bond strength of each emboss sample was determined using James River Ply Bond Test Method M-082. This ply bond data was then normalized for pressure using the data collected from the pressure sensitive tape. Figure 12 represents the results of those tests and demonstrates the clear superiority of pattern # 8204 in terms of ply bond strength.

The second test represented by Figure 13 compared pattern # 8204 against other prototype test patterns and pattern # 6217, a commercially available ply bonding pattern used also in the test for Figure 12. In this test all patterns were engraved on the same steel roll so that the pressure applied during testing was exactly the same for all patterns. All the patterns in this test, except for #8846F, were male patterns wherein the etched area comprised projections from the roll surface impressed into an impressionable surface; both male and female versions of pattern 8846 were tested. The steel engraved roll was pressed into a conventional fiber filled roll and 6 samples of 2-ply napkins stock were passed through the nip of each coin edge emboss pattern. The ply bond strength of each sample was determined using James River Test Method M-082. Figure 13 represents the results of those test and clearly demonstrates the superiority of the male version of the pattern of the invention as represented by pattern # 8204 as opposed to the male version of commercially available pattern # 6217 and other prototype test patterns.

The tests represented by Figure 14 were performed in the same manner as those whose results are depicted in Figure 13. In these tests, all engraved patterns were female except for #8846M; both the male and female versions of pattern #8846 were tested as they were in conjunction with Figure 13. The other difference was the paper substrate used. In the tests for Figure 13 commercially available Wauna 2-ply paper from James River's Wauna plant was used; in the tests for Figure 14, paper produced on a laboratory low speed pilot machine (LSPM) was used. Again, Figure 14 confirms the advantages of the pattern of the invention, #8204. The missing bars for patterns 6217F and 8846F indicate that the samples produced at those pressures for those patterns were not tested for bonding strength.

Figure 15 represents the results of another test performed in the same manner as those related to Figures 13 and 14. This test was on LSPM substrate at 21093 kg/m^2 (30 psi) and again illustrates the improvements obtained using the pattern of the invention. The difference between the 21093 kg/m^2 (30 psi) result in Figure 13 and the results for the same patterns at 21093 kg/m^2 (30 psi) in Figure 15 represents the effect of different paper substrates. Since the paper will have an effect on the resulting bond, no meaningful conclusion can be reached by comparing test results using different substrates, but, as seen again in Figure 15, the pattern of the invention is clearly superior to other patterns applied to the same substrate at comparable pressures.

The patterns against which pattern #8204 was compared in Figures 12-15 are identified by the pattern number accorded them by their manufacturer, Industrial Engraving Company, Pulaski, Wisconsin. These patterns are available to James River Corportion of Virginia for commercial coin edge embossing.

All of the test data presented in Figures 12-15 represent steel engraved patterns used in opposition to an impressionable surface, such as a cotton filled roll. The tests not only demonstrate the superiority of the pattern of the invention, but also demonstrate that the female version provides greater bond strength than the male version or the same pattern (compare #8204F, 21093 kg/m^2 (30 psi) in Fig. 14 with #8204M in Figure 15. While the reasons for the better bond with the female version is not entirely understood, the way the impressionable surface takes and holds an impressed shape is believed to contribute to the difference.

The embodiment of the invention using cooperating, meshing engraved male and female patterns as depicted in Figure 3 is currently considered the best mode of the invention, not because it provides significantly better emboss bonds, but because the opposed metal-surfaced roll having a cooperating etched area has a longer useful life and provides more consistent emboss bonds over a longer period than when a roll with an impressionable surface is used.

The data depicted in Figure 16 represents a comparison of the plybond strength of the pattern of the invention (#8204) to other patterns when formed on the same type of substrate by opposed steel rolls with meshing etched areas, a female steel roll in opposition to an impressionable surface, and a male steel roll in opposition to an impressionable surface. For the steel to steel tests, the nip defined by the rolls had a fixed spacing of approximately 0.05 mm (.002"). The data demonstrates that the invention provides superior emboss bonding when compared to the other patterns whether formed using an etched steel roll and an impressionable roll surface of opposed steel rolls having meshing etched patterns. As indicated for the pattern of the invention, the plybond performance of steel/steel is not significantly better than female steel/impressionable surface.

The test results clearly demonstrate the benefit of the claimed apparatus and method by providing a superior emboss bond for lightweight cellulosic articles.

Claims

1. An apparatus for emboss bonding two or more lightweight cellulosic webs (64) to form a multiply article, the apparatus comprising:

   a pair of rolls (20, 60) disposed for cooperative rotation about parallel cross machine axes (24, 61) and defining a nip (62) between the surfaces thereof; and

   means (26, 66) on the cooperating surfaces of said rolls for forming on webs introduced into said nip an emboss pattern comprising a plurality of truncated right rectangular pyramids (28) projecting from one surface of said webs in aligned adjacent relationship in the machine direction (MD) and the cross machine direction (CD), the forming means on one of the said rolls comprising a plurality of truncated right rectangular pyramidal cavities in said roll surface, each said cavity being defined by an axis (30) coaxial with a radius of one of said rolls, a base (32) defining an opening in the surface of said one roll, a generally planar apex (34) axially spaced from said base and generally perpendicular to said axis, and sidewalls (36, 38) extending between said base and said apex, said sidewalls diverging from said apex at an angle to said axis in the range of about 25° to about 40°.

2. Apparatus as claimed in claim 1 wherein said emboss pattern forming means form an emboss bond proximate the perimeter of the article.

3. The apparatus of claim 1 or claim 2 wherein one said roll has a metal surface 22 and wherein said plurality of truncated right rectangular pyramidal cavities comprise an etched area (26) on the surface of said one roll, said cavities being disposed in said roll surface in adjacent CD and MD relationship.

4. The apparatus of any one of claims 1 to 3 wherein the plurality of truncated right rectangular pyramidal cavities comprise:

   an apex having a CD dimension in the range of about 0.635mm (.025") to about 1.27mm (.050"); a MD dimension in the range of about 0.508mm (.020") to about 1.27mm (.050"); and a MD/CD dimension ratio of at least about 2/3, the axial distance between said base and said apex being in the range of about 0.254mm (.010") to about 0.305mm (.012").

5. The apparatus of claim 4 wherein said apex has a CD dimension of about 0.686mm (.027") and a MD dimension of about 0.508mm (.02"), wherein the axial distance between said apex and said base is about 0.305mm (.012"), wherein the walls diverging from the apex in the CD direction are at an angle to the axis of about 40° and wherein the wall diverging from the apex in the MD direction are at an angle to the axis of about 25°.

6. The apparatus of any one of claims 3 to 5 wherein the combined area of the planar apices of said cavities is at least about 30% of the area of said embossed pattern.

7. The apparatus of any one of claims 3 to 6 wherein the predetermined dimension of said etched area is selected to form an embossed pattern having an area of at least about 9674.4mm^2 (15 square inches) per gram of article weight.

8. The apparatus of any one of claims 3 to 7 wherein said etched area defines at least one rectangle two parallel sides of which extend circumferentially on the surface of said one roll and two parallel sides of which extend on the surface of said one roll in the cross machine direction.

9. The apparatus of claim 9 wherein the sides of said etched area are disposed to form an embossed bond extending from the edge of said article a width in the range of about 6.35mm (.25") to about 38.1mm (1.5").

10. The apparatus of any one of claims 3 to 9 wherein said etched area defines two parallel patterns of said cavities spaced about 6.35mm (.25").

11. The apparatus of any one of claims 3 to 10 wherein the other said roll has an impressionable surface capable of conforming under pressure to said etched area.

12. The apparatus of claim 11 wherein said other roll is a cotton filled emboss roll.

13. The apparatus of any one of claims 3 to 12 wherein the other said roll has a metal surface including a cooperating etched area having said predetermined dimensions, the cooperating etched area comprising a plurality of truncated right rectangular pyramids projecting

from the surface of the other roll for meshing engagement with the cavities in the surface of said one roll.

14. A method of forming a lightweight paper product having a parametric edge and including a plurality of cellulosic webs attached together by an emboss bond proximate said edge, the method comprising introducing said webs into a nip defined by a pair of cooperating rotating rolls, one said roll having a metal surface and an etched area on the surface defining a pattern having predetermined dimensions for forming said emboss bond proximate said edge, said etched area comprising a plurality of truncated right rectangular pyramidal cavities in said roll surface disposed in adjacent relationship in the machine and cross machine directions each said cavity being defined by an axis coaxial with a radius of one of said rolls, a base defining an opening in the surface of said one roll, a generally planar apex axially spaced from said base and generally perpendicular to said axis, and sidewalls extending between said base and said apex, the sidewalls diverging from said apex at an angle to said axis in the range of about 25° to about 40°, and said other roll having a surface including means for mating with said etched area to form said emboss bond.

15. A method according to claim 14 wherein the plurality of right rectangular cavities comprise:

an apex having a CD dimension in the range of about 0.635mm (.025") to about 1.27mm (.050"); a MD dimension in the range of about 0.508mm (.020") to about 1.27mm (.050"); and a MD/CD dimension ratio of at least about 2/3, the axial distance between said base and said apex being in the range of about 0.254mm (.010") to about 0.305mm (.012").

16. A lightweight paper product comprising the product of emboss bonding a plurality of cellulosic webs having opposing surfaces characterised in that the emboss pattern comprises a plurality of truncated right rectangular pyramids projecting from one surface of said webs in aligned adjacent relationship in mutually perpendicular directions the dimension and shape of each said pyramid being defined by the process of press forming said webs into a truncated right rectangular pyramidal cavity having a base defining the opening of said cavity, a generally planar, rectangular apex axially spaced from said base, and generally planar sidewalls extending between said base and said apex, the sidewalls diverging from said apex at an angle to said axis in the range of about 25° to about 40°.

17. A lightweight paper product as claimed in claim 16 which has opposed pairs of side and end edges and wherein the emboss bond comprises a peripheral zone extending inwardly from said edges with a width of 6.35mm (0.25") to 38.1mm (1.5").

18. A lightweight paper product as claimed in claim 17 having two zones of emboss bonding spaced apart by about 6.35mm (0.25").

19. A lightweight paper product as claimed in any one of claims 16 to 18 in which the embossed area is about 9674.4mm^2 (15 square inches) per gram of the product.

20. A lightweight paper product as claimed in any one of claims 16 to 19 wherein the total area of the apices of the pyramids is at least about 30% of the total embossed area of the product.

21. A lightweight paper product as claimed in any one of claims 16 to 20 wherein the orthogonal transverse dimensions of the apex have a ratio of at least about 3/2.

22. A lightweight papers product as claimed in any one of claims 16 to 21 wherein the truncated right rectangular pyramids are adjacently disposed throughout the area of the pattern in rows and columns parallel to the respective edges, one transverse dimension of said apex parallel to said side edges being in the range of about 0.635mm (.025") to about 1.27mm (.050"), the other transverse dimension of said apex being in the range of about 0.508mm (.020") to about 1.27mm (.050") and the ratio of the one transverse dimension to the other dimension being at least 3/2, the axial distance between said base and said apex being in the range of about 0.25mm (.010") to about 0.305mm (.012").

23. A lightweight paper product according to any one of claims 16 to 22 wherein the dimension and shape of each pyramid is defined by the process of press facing the webs into the truncated right rectangular pyramidal cavity by means of a formed male projection having dimensions and dispositions corresponding to said cavity for cooperative meshing therewith.

24. A lightweight paper product according to any one of claims 16 to 23 wherein the truncated

right rectangular pyramids have a base defining a rectangular opening in the other surface of said product, a generally planar, rectangular apex generally parallel to and spaced from said one surface, the orthogonal transverse dimensions of said apex having a ratio of at least about 2/3 with the longer dimension being parallel to said side edges, and generally planar sidewalls extending from said one surface to said apex, the area of the apices of said pyramids being at least about 30% of the area of said pattern.

Patentansprüche

1. Apparat für die Prägungsbindung von zwei oder mehr leichten Cellulosegeweben (64) zur Herstellung eines mehrlagigen Artikels umfassend
ein Paar Walzen (20, 60) die für die zusammenwirkende Rotation um parallele Querachsen (24, 61) angeordnet sind und einen Berührungspunkt (62) zwischen deren Oberflächen definieren, und
Vorrichtungen (26, 66) auf den zusammenwirkenden Oberflächen dieser Walzen zur Erzeugung eines Prägemusters auf in diesen Berührungspunkt eingeführten Geweben, wobei das Muster eine Vielzahl abgeschnittener rechteckiger Pyramiden (28) umfaßt, die von einer Oberfläche dieser Gewebe in einem nebeneinander angeordneten Verhältnis in Maschinenrichtung (machine direction = MD) und Maschinenquerrichtung (cross machine direction = CD) ragen, wobei die Formvorrichtung auf einer der Walzen eine Vielzahl abgeschnittener rechteckiger pyramidenförmiger Vertiefungen auf der Walzenoberfläche umfaßt und jede Vertiefung durch eine Achse (30) definiert wird, welche coaxial mit einem Radius einer der Walzen liegt, eine Basis (32), die eine Öffnung in der Oberfläche der einen Walze definiert, eine im allgemeinen ebene Spitze, die sich axial im Abstand zu dieser Basis befindet und im allgemeinen senkrecht zur Achse liegt, sowie Seitenwände, die von der Basis bis zur Spitze reichen und von dieser Spitze in einem Winkel im Bereich von etwa 25 °C bis etwa 40 °C auseinandergehen.

2. Apparat nach Anspruch 1, bei dem die Vorrichtung zur Bildung des Prägemusters eine annähernd der äußeren Umgrenzungslinie des Artikels entsprechende Prägungsbindung bildet.

3. Apparat nach Anspruch 1 oder 2, bei dem die Walze eine Metalloberfläche (22) aufweist und bei dem die Vielzahl der abgeschnittenen rechteckigen pyramidenförmigen Vertiefungen einen geätzten Bereich (26) auf der Oberfläche der Walze umfaßt, wobei die Vertiefungen in einem aneinander angrenzenden CD- und MD-Verhältnis angeordnet sind.

4. Apparat nach einem der Ansprüche 1 bis 3, bei dem die Vielzahl der abgeschnitten rechteckigen pyramidenförmigen Vertiefungen eine Spitze mit einer CD-Abmessung im Bereich von etwa 0,635 mm (.025") bis etwa 1,27 mm (.050"), einer MD-Abmessung im Bereich von etwa 0,508 mm (.020") bis etwa 1,27 mm (.050") und einem MD/CD-Abmessungsverhältnis von mindestens etwa 2/3 umfasßt, wobei der axiale Abstand zwischen der Basis und der Spitze im Bereich von etwa 0,254 mm (.010") bis etwa 0,305 mm (.012") liegt.

5. Apparat nach Anspruch 4, bei dem die Spitze eine CD-Abmessung von etwa 0,686 mm (.027") und eine MD-Abmessung von etwa 0,508 mm (.02") aufweist, der axiale Abstand zwischen der Spitze und der Basis etwa 0,305 mm (.012") beträgt, die von der Spitze in CD-Richtung auseinandergehenden Wände sich in einem Winkel von etwa 40 ° zur Achse befinden und die von der spitze in MD-Richtung auseinandergehenden Wände sich in einem Winkel von etwa 25 ° zur Achse befinden.

6. Apparat nach einem der Ansprüche 3 bis 5, bei dem die kombinierte Fläche der ebenen Spitzen dieser Vertiefungen mindestens etwa 30 % der Fläche des Prägemusters ausmacht.

7. Apparat nach einem der Ansprüche 3 bis 6, bei dem die vorher festgelegte Abmessung des geätzten Bereichs so gewählt wird, daß sie ein Prägemuster mit einer Fläche von mindestens etwa 9674,4 mm^2 (15 square inches) pro Gramm Gewicht des Artikels bildet.

8. Apparat nach einem der Ansprüche 3 bis 7, bei dem der geätzte Bereich mindestens ein Rechteck definiert, von dem zwei parallele Seiten peripherisch auf die Oberfläche der einen Walze und zwei parallele Seiten auf die Oberfläche der einen Walze in Querrichtung der Maschine reichen.

9. Apparat nach Anspruch 8, bei dem die Seiten des geätzten Bereichs so angeordnet sind, daß sie eine Prägebindung bilden, die vom Rand des Artikels über eine Breite im Bereich von etwa 6,35 mm (.25") bis etwa 38,1 mm (1.5") reicht.

10. Apparat nach einem der Ansprüche 3 bis 9, bei dem der geätzte Bereich zwei parallele Muster der in einem Abstand von etwa 6,35 mm (.25") angeordneten Vertiefungen bildet.

11. Apparat nach einem der Ansprüche 3 bis 10, bei dem die andere Walze eine prägungsfähige Oberfläche aufweist, die sich unter Druck dem geätzten Bereich anpassen kann.

12. Apparat nach Anspruch 11, bei dem die andere Walze eine mit Baumwolle gefüllte Prägewalze ist.

13. Apparat nach einem der Ansprüche 3 bis 12, bei dem die andere Walze eine Metalloberfläche einschließlich eines zusammenwirkenden geätzten Bereichs mit den vorher festgelegten Abmessungen aufweist, wobei der zusammenwirkende geätzte Bereich eine Vielzahl von abgeschnittenen rechteckigen Pyramiden umfaßt, die von der Oberfläche der anderen Walze ragen, um mit den Vertiefungen in der Oberfläche der einen Walze maschenförmig ineinanderzugreifen.

14. Verfahren zur Herstellung eines leichten Papierprodukts mit einer parametrischen Kante und einer Vielzahl von Cellulosegeweben, die durch eine entlang dieser Kante verlaufenden Prägebindung miteinander verbunden sind, bei dem diese Gewebe in eine Berührungsstelle eingeführt werden, die durch ein Paar zusammenwirkende Walzen definiert ist, von denen eine eine Metalloberfläche und einen geätzten Bereich auf der Oberfläche mit vorbestimmten Abmessungen zur Bildung der Prägebindung entlang der Kante aufweist, wobei der geätzte Bereich eine Vielzahl abgeschnittener rechtekkiger pyramidenförmiger Vertiefungen in der Walzenoberfläche aufweist, die in einem angrenzenden Verhältnis in Richtung und Querrichtung der Maschine angeordnet sind, wobei jede Vertiefung durch eine Achse definiert ist, die coaxial mit einem Radius einer der Walzen liegt, einer Basis, die eine Öffnung in der Oberfläche der einen Walze definiert, einer im allgemeinen ebenen Spitze, die sich axial im Abstand zu dieser Basis befindet und im allgemeinen senkrecht zur Achse liegt, sowie Seitenwänden, die von der Basis bis zur Spitze reichen und von dieser Spitze in einem Winkel im Bereich von etwa 25 °C bis etwa 40 °C auseinandergehen, und wobei die andere Walze eine Oberfläche aufweist, die eine Vorrichtung zur Paarung mit dem geätzten Bereich zur Bildung der Prägebindung aufweist.

15. Verfahren nach Anspruch 14, bei dem die Vielzahl der abgeschnitten rechteckigen pyramidenförmigen Vertiefungen
eine Spitze mit einer CD-Abmessung im Bereich von etwa 0,635 mm (.025") bis etwa 1,27 mm (.050"), einer MD-Abmessung im Bereich von etwa 0,508 mm (.020") bis etwa 1,27 mm (.050") und einem MD/CD-Abmessungsverhältnis von mindestens etwa 2/3 umfaßt, wobei der axiale Abstand zwischen der Basis und der spitze im Bereich von etwa 0,254 mm (.010") bis etwa 0,305 mm (.012") liegt.

16. Leichtes Papierprodukt, umfassend das Produkt der Prägungsbindung einer Vielzahl von Cellulosegeweben mit gegenüberliegenden Oberflächen, dadurch gekennzeichnet, daß das Prägemuster eine Vielzahl von abgeschnittenen rechteckigen Pyramiden, die von einer Oberfläche der Gewebe in einem nebeneinander angeordneten Verhältnis in wechselseitig senkrechten Richtungen ragen, wobei die Dimension und Form jeder Pyramide durch das Verfahren zum Preßformen der Gewebe zu einer Vertiefung in Form einer abgeschnittenen rechteckigen Pyramide definiert wird und die Vertiefung eine Basis aufweist, die ihre Öffnung definiert, eine im allgemeinen ebene, rechteckige Spitze, die axial im Abstand von der Basis angeordnet ist, und im allgemeinen ebene Seitenwände, die von der Basis zur Spitze reichen und von der spitze in einem Winkel von etwa 25 ° bis etwa 40 ° zur Achse auseinandergehen, umfaßt.

17. Leichtes Papierprodukt nach Anspruch 16, das gegenüberliegende Seiten und Endkantenpaare aufweist und bei dem die Prägungsbindung eine periphäre Zone umfaßt, die von den Kanten mit einer Breite von 6,35 mm (0.25") bis 38,1 mm (1,5") nach innen reicht.

18. Leichtes Papierprodukt nach Anspruch 17 mit zwei Prägungsbindungszonen, die im Abstand von etwa 6,35 mm (0,25") auseinanderliegen.

19. Leichtes Papierprodukt nach einem der Ansprüche 16 bis 18, bei dem die geprägte Fläche etwa 9674,4 mm^2 (15 square inches) pro Gramm Produkt ausmacht.

20. Leichtes Papierprodukt nach einem der Ansprüche 16 bis 19, bei dem der Gesamtbereich der Spitzen der Pyramiden mindestens etwa 30 % der gesamten geprägten Fläche des Produkts ausmacht.

21. Leichtes Papierprodukt nach einem der Ansprüche 16 bis 20, bei dem orthogonalen schräg verlaufenden Abmessungen der Spitze ein Verhältnis von mindestens etwa 3/2 aufweisen.

22. Leichtes Papierprodukt nach einem der Ansprüche 16 bis 21, bei dem die abgeschnittenen rechteckigen Pyramiden über die Fläche des Musters in Reihen und Spalten parallel zu den jeweiligen Kanten angeordnet sind, wobei eine diagonale Abmessung der Spitze parallel zu den Seitenkanten im Bereich von etwa 0,635 mm (.025") bis etwa 1,27 mm (.050") liegt, die andere diagonale Abmessung der Spitze im Bereich von etwa 0,508 mm (.020") bis etwa 1,27 mm (.050) liegt und das Verhältnis der einen diagonalen Abmessung zur anderen Abmessung mindestens 3/2 beträgt und der axiale Abstand zwischen der Basis und der Spitze im Bereich von etwa 0,25 mm (.010") bis etwa 0,305 mm (.012") liegt.

23. Leichtes Papierprodukt nach einem der Ansprüche 16 bis 22, bei dem die Abmessung und Form jeder Pyramide durch das Verfahren der Drückens der Gewebe in die abgeschnittene rechteckige pyramidenförmige Vertiefung mittels einer geformten Auskragung, deren Abmessungen und Anordnungen der Vertiefung entsprechen, zur zusammenwirkenden Vermaschung definiert wird.

24. Leichtes Papierprodukt nach einem der Ansprüche 16 bis 23, bei dem die abgeschnittenen rechteckigen Pyramiden eine Basis, die eine rechteckige Öffnung in der anderen Oberfläche des Produkts definiert, eine im allgemeinen ebene, rechteckige Spitze, die sich im allgemeinen parallel und im Abstand zur einen Oberfläche befindet, wobei die orthogonalen diagonalen Abmessungen der Spitze ein Verhältnis von mindestens etwa 2/3 aufweisen und die längere Abmessung parallel zu den Seitenkanten liegt, und im allgemeinen ebene Seitenwände aufweisen, die von der einen Oberfläche zur Spitze reichen, wobei die Flächen der Spitzen der Pyramiden mindestens etwa 30 % der Fläche des Musters ausmachen.

Revendications

1. Appareil pour lier par gaufrage deux ou plusieurs feuilles cellulosiques légères (64) de façon à former un article à couches multiples, l'appareil comprenant :

deux rouleaux (20,60) disposés pour une rotation en coopération autour d'axes parallèles (24,61) transversaux à la direction de machine et définissant entre leurs surfaces un pincement (62) ; et

des moyens (26,66) prévus sur les surfaces coopérantes desdits rouleaux pour former, sur les feuilles introduites dans ledit pincement, une configuration de gaufrage comportant une pluralité de pyramides rectangulaires droites tronquées (28) qui font saillie par rapport à une surface desdits rouleaux,en relation adjacente alignée dans la direction de machine (MD) et dans la direction transversale (CD), les moyens de formage sur un premier desdits rouleaux comprenant une pluralité de cavités pyramidales rectangulaires droites tronquées ménagées dans ladite surface du rouleau, chaque dite cavité étant définie par un axe (30) coaxial à un rayon d'un premier desdits rouleaux, une base (32) définissant une ouverture dans la surface dudit premier rouleau, un sommet sensiblement plan (34) axialement espacé de la dite base et sensiblement perpendiculaire audit axe, et des parois latérales (36,38) s'étendant entre ladite base et ledit sommet, lesdites parois latérales divergeant à partir dudit sommet suivant un angle,par rapport audit axe, compris entre 25 ° environ et 40 ° environ.

2. Appareil suivant la revendication 1, dans lequel lesdits moyens de formage d'une configuration de gaufrage engendrent une liaison par gaufrage voisine du périmètre de l'article.

3. Appareil suivant la revendication 1 ou la revendication 2, dans lequel un premier rouleau présente une surface métallique (22), et dans lequel la dite pluralité de cavités pyramidales rectangulaires droites tronquées constituent une région gravée (26) sur la surface dudit premier rouleau, lesdits cavités étant disposées dans ladite surface du rouleau de façon adjacente dans les directions CD et MD.

4. Appareil suivant une quelconque des revendications 1 à 3, dans lequel la pluralité de cavités pyramidales rectangulaires droites tronquées présentent :

un sommet ayant une dimension CD comprise entre 0,635 mm environ et 1,27 mm environ, une dimension MD comprise entre 0,508 mm environ et 1,27 mm environ, et un rapport des dimensions MD/CD d'au moins 2/3 environ, la distance axiale entre ladite base et ledit sommet étant comprise entre 0,254 mm environ et 0,305 mm environ.

5. Appareil suivant la revendication 4, dans lequel ledit sommet a une dimension CD de 0,686

mm environ et une dimension MD de 0,508 mm environ, dans lequel la distance axiale entre ledit sommet et ladite base est de 0,305 mm environ, dans lequel les parois qui divergent à partir du sommet dans la direction CD forment un angle de 40° environ par rapport à l'axe, et dans lequel les parois qui divergent à partir du sommet dans la direction MD forment un angle de 25° environ par rapport à l'axe.

6. Appareil suivant une quelconque des revendications 3 à 5, dans lequel la surface combinée des sommets plans desdites cavités représente au moins 30% environ de la surface de ladite configuration gaufrée.

7. Appareil suivant une quelconque des revendications 3 à 6, dans lequel la dimension prédéterminée de ladite région gravée est choisie pour former une configuration gaufrée ayant une surface d'au moins 9674,4 mm^2 environ par gramme de poids d'article.

8. Appareil suivant une quelconque des revendications 3 à 7, dans lequel ladite région gravée définit au moins un rectangle dont deux côtés parallèles s'étendent circonférentiellement sur la surface dudit premier rouleau et dont deux côtés parallèles s'étendent sur la surface dudit premier rouleau dans la direction transversale.

9. Appareil suivant la revendication 8, dans lequel les côtés de ladite région gravée sont disposés de manière à former une liaison gaufrée s'étendant, à partir du bord dudit article, sur une largeur de 6,35 mm environ à 38,1 mm environ.

10. Appareil suivant une quelconque des revendications 3 à 9, dans lequel ladite région gravée définit deux configurations parallèles de dites cavités espacées de 6,35 mm environ.

11. Appareil suivant une quelconque des revendications 3 à 10, dans lequel ledit autre rouleau présente une surface d'empreinte qui peut se conformer sous pression à ladite région gravée.

12. Appareil suivant la revendication 11, dans lequel ledit autre rouleau est un rouleau de gaufrage garni de coton.

13. Appareil suivant une quelconque des revendications 3 à 12, dans lequel ledit autre rouleau présente une surface métallique comportant une région gravée coopérante qui a lesdites dimensions prédéterminées, la région gravée coopérante comprenant une pluralité de pyramides rectangulaires droites tronquées qui font saillie par rapport à la surface dudit autre rouleau pour s'accoupler avec les cavités de la surface dudit premier rouleau.

14. Procédé de fabrication d'un produit en papier léger ayant un bord périmétrique et incluant une pluralité de voiles cellulosiques attachés les uns aux autres par une liaison gaufrée près dudit bord, le procédé comprenant l'introduction desdits voiles dans un pincement défini par deux rouleaux rotatifs coopérants, un dit premier rouleau présentant une surface métallique et une région gravée sur la surface pour définir une configuration de dimensions prédéterminées afin de former ladite liaison gaufrée près dudit bord, ladite région gravée comprenant une pluralité de cavités pyramidales rectangulaires droites tronquées ménagées dans ladite surface du rouleau et disposées en relation adjacente dans la direction de machine et dans la direction transversale, chaque dite cavité étant définie par un axe coaxial à un rayon d'un premier desdits rouleaux, par une base définissant une ouverture dans la surface dudit premier rouleau, par un sommet sensiblement plan axialement espacé de ladite base et sensiblement perpendiculaire au dit axe et par des parois latérales s'étendant entre la dite base et ledit sommet, les parois latérales divergeant à partir dudit sommet suivant un angle compris entre 25° environ et 40° environ par rapport audit axe, et ledit autre rouleau présentant une surface comportant des moyens de coopération avec ladite région gravée, pour former ladite liaison par gaufrage.

15. Procédé suivant la revendication 14, dans lequel la pluralité de cavités pyramidales rectangulaires droites ont :

un sommet ayant une dimension CD comprise entre 0,635 mm environ et 1,27 mm environ, une dimension MD comprise entre 0,508 mm environ et 1,27 mm environ, et un rapport des dimensions MD/CD d'au moins 2/3 environ, la distance axiale entre ladite base et ledit sommet étant comprise entre 0,254 mm environ et 0,305 mm environ.

16. Produit en papier léger comprenant le produit de la liaison par gaufrage d'une pluralité de voiles cellulosiques ayant des surfaces opposées, caractérisé en ce que la configuration de gaufrage comprend une pluralité de pyramides rectangulaires droites tronquées qui font saillie par rapport à une surface desdits voiles en relation adjacente alignée dans des directions

mutuellement perpendiculaires, la dimension et la forme de chaque dite pyramide étant définies par le formage par pression desdits voiles dans une cavité pyramidale rectangulaire droite tronquée ayant une base qui définit l'ouverture de ladite cavité, un sommet rectangulaire sensiblement plan axialement espacé de ladite base, et des parois latérales sensiblement planes s'étendant entre ladite base et ledit sommet, les parois latérales divergeant à partir dudit sommet suivant un angle compris entre 25° environ et 40° environ par rapport audit axe.

17. Produit en papier léger suivant la revendication 16, qui présente des paires opposées de bords latéraux et d'extrémité, et dans lequel la liaison par gaufrage comprend une zone périphérique s'étendant vers l'intérieur à partir desdits bords sur une largeur de 6,35 mm à 38,1 mm.

18. Produit en papier léger suivant la revendication 17, comportant deux zones de liaison par gaufrage mutuellement espacées de 6,35 mm environ.

19. Produit en papier léger suivant une quelconque des revendications 16 à 18, dans lequel la surface gaufrée est de 9674,4 mm^2 environ par gramme du produit.

20. Produit en papier léger suivant une quelconque des revendications 16 à 19, dans lequel la surface totale des sommets des pyramides représente au moins 30% environ de la surface gaufrée totale du produit.

21. Produit en papier léger suivant une quelconque des revendications 16 à 20, dans lequel les dimensions transversales orthogonales du sommet sont dans un rapport d'au moins 3/2 environ.

22. Produit en papier léger suivant une quelconque des revendications 16 à 21, dans lequel les pyramides rectangulaires droites tronquées sont disposées de façon adjacente dans toute la surface de la configuration, en rangées et colonnes parallèles aux bords respectfis, une première dimension transversale dudit sommet, parallèle auxdits bords latéraux, étant comprise entre 0,635 mm environ et 1,27 mm environ, l'autre dimension transversale dudit sommet étant comprise entre 0,508 mm environ et 1,27 mm environ, et le rapport de la première dimension transversale à l'autre dimension étant au moins de 3/2, la distance axiale entre ladite base et ledit sommet étant comprise entre 0,25 mm environ et 0,305 mm environ.

23. Produit en papier léger suivant une quelconque des revendications 16 à 22, dans lequel la dimension et la forme de chaque pyramide sont définies par le formage à la presse des voiles dans la cavité pyramidale rectangulaire droite tronquée, au moyen d'une saillie mâle de formage ayant des dimensions et des dispositions qui correspondent à ladite cavité pour engrener de façon coopérante avec celle-ci.

24. Produit en papier léger suivant une quelconque des revendications 16 à 23, dans lequel les pyramides rectangulaires droites tronquées ont une base définissant une ouverture rectangulaire dans l'autre surface dudit produit, un sommet rectangulaire sensiblement plan sensiblement parallèle à ladite première surface et espacé de celle-ci, les dimensions transversles orthogonales dudit sommet étant dans un rapport d'au moins 2/3 environ et la plus grande dimension étant parallèle aux dits bords latéraux, et des parois latérales sensiblement planes s'étendant de ladite première surface jusqu'au dit sommet, la surface des sommets desdites pyramides représentant au moins 30% environ de la surface de ladite configuration.

Fig.1

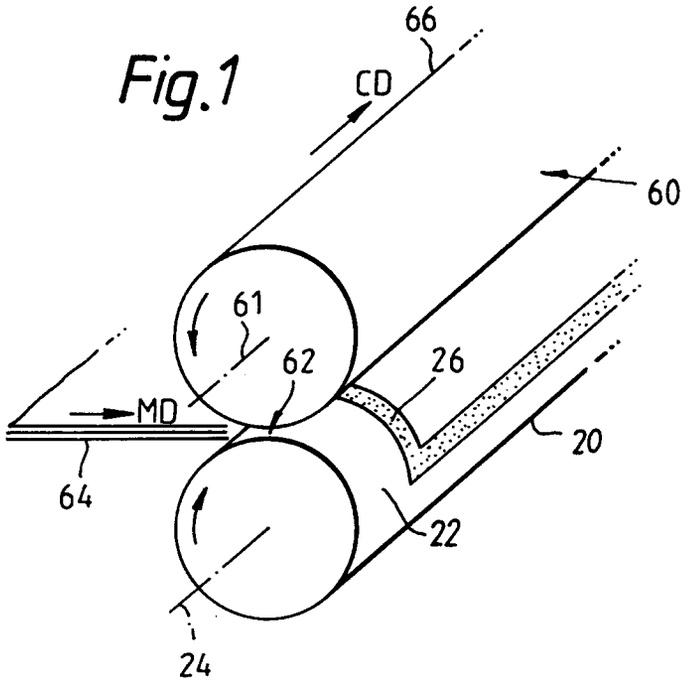


Fig.2

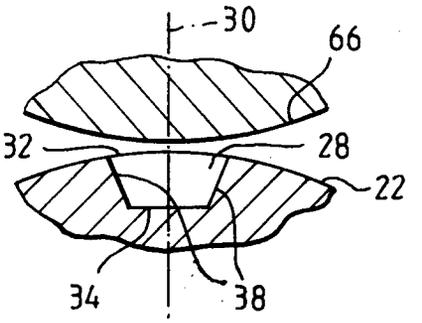


Fig.3

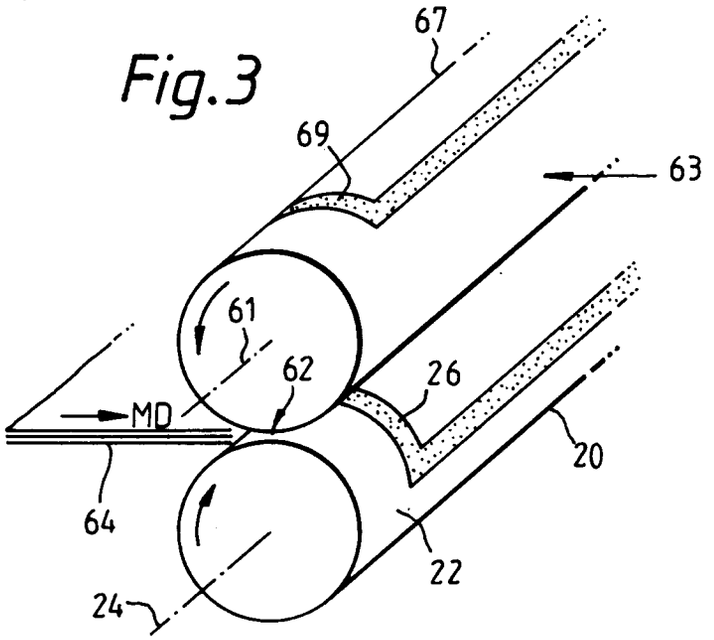


Fig.4

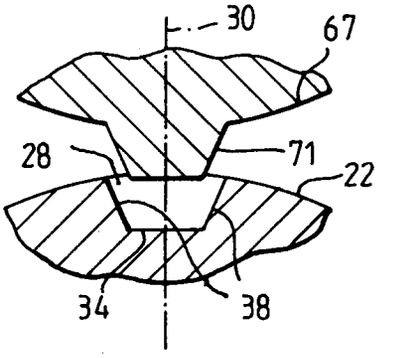


Fig.5

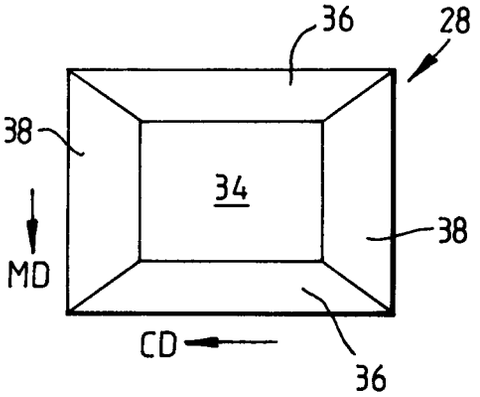


Fig.6

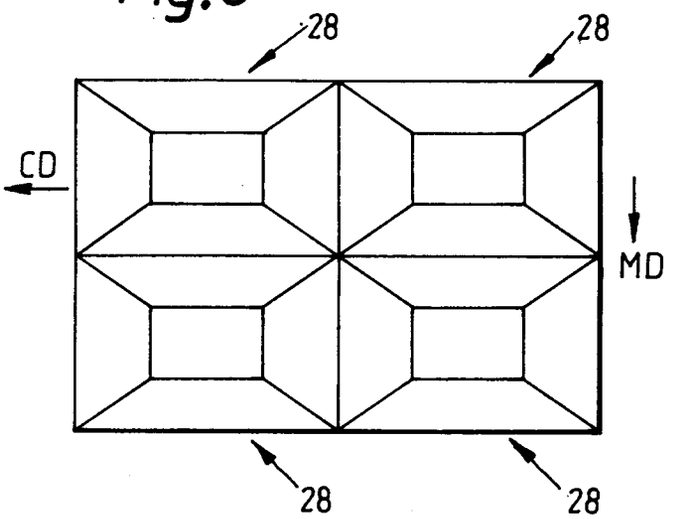


Fig.7

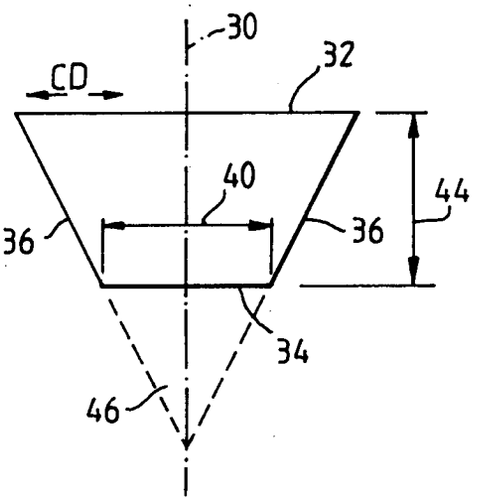


Fig.8

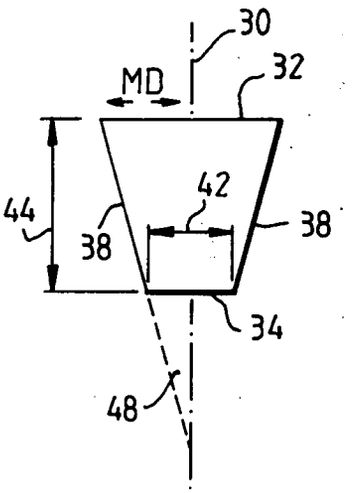


Fig.9

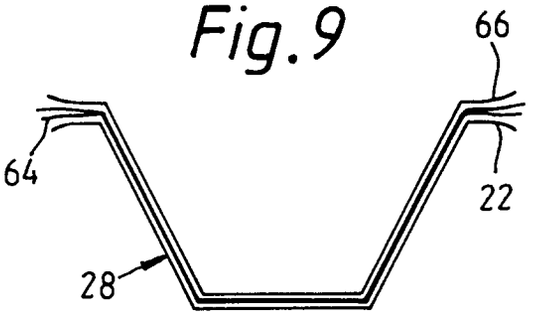


Fig.10

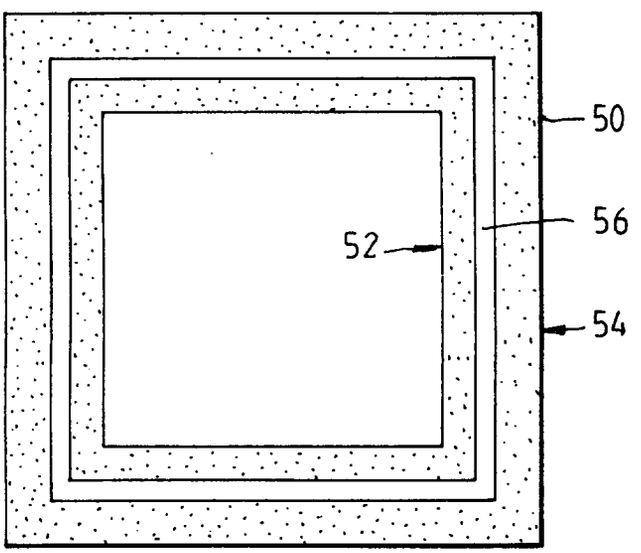


Fig.11

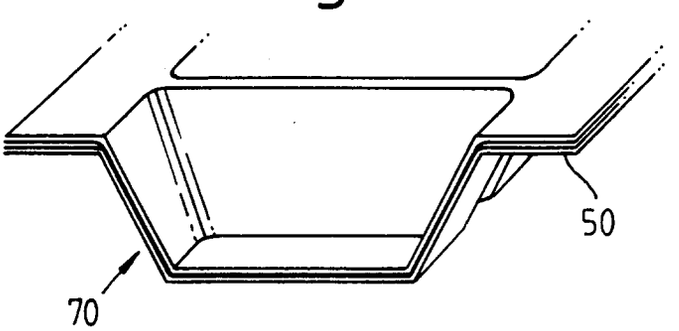
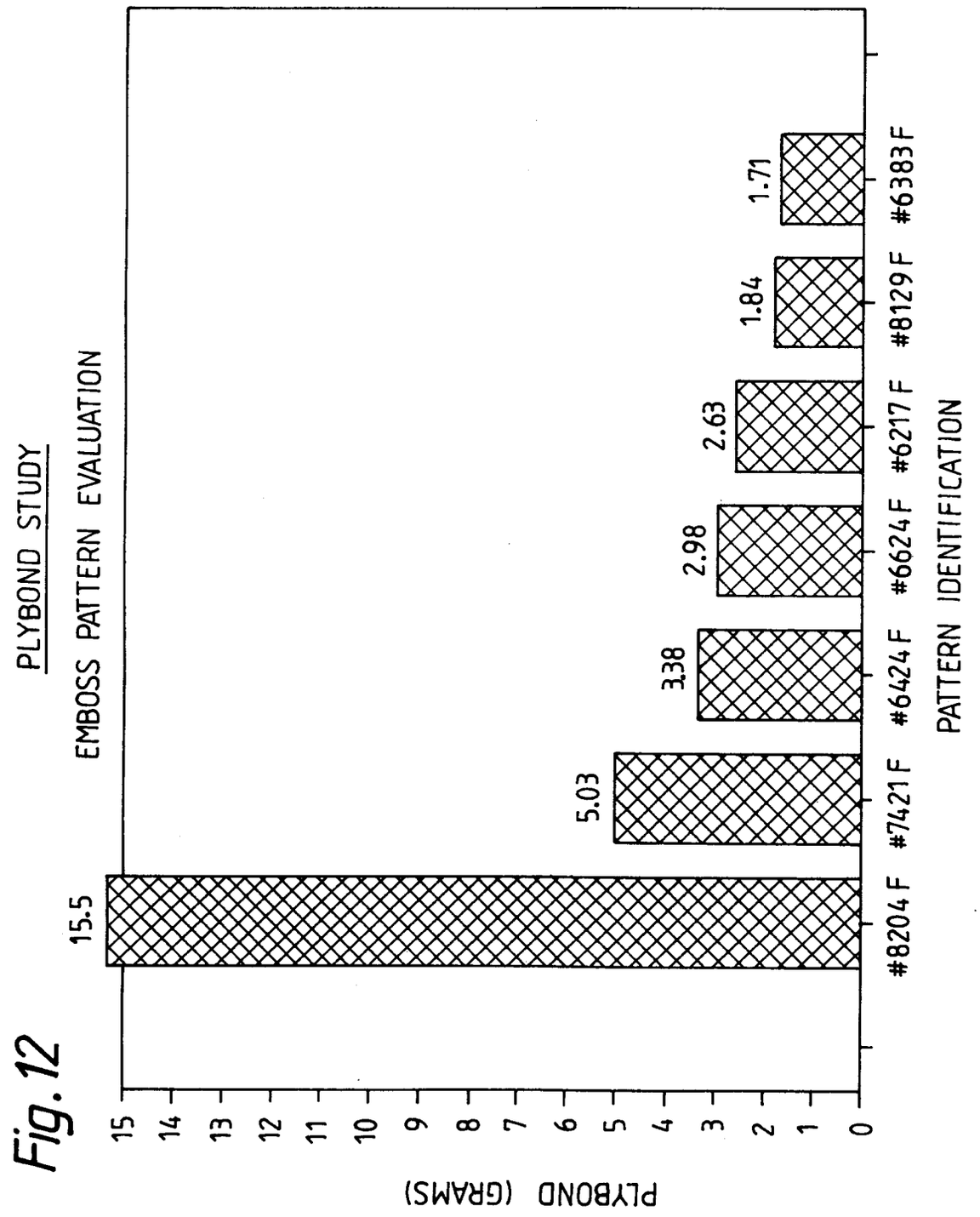


Fig. 12


PLYBOND STUDY
EMBOSS PATTERN EVALUATION
PLYBOND (GRAMS)
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2
3
4
5
6
7
8
9
10
11
12
13
14
15
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2.63
1.84
1.71
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#6424 F
#6624 F
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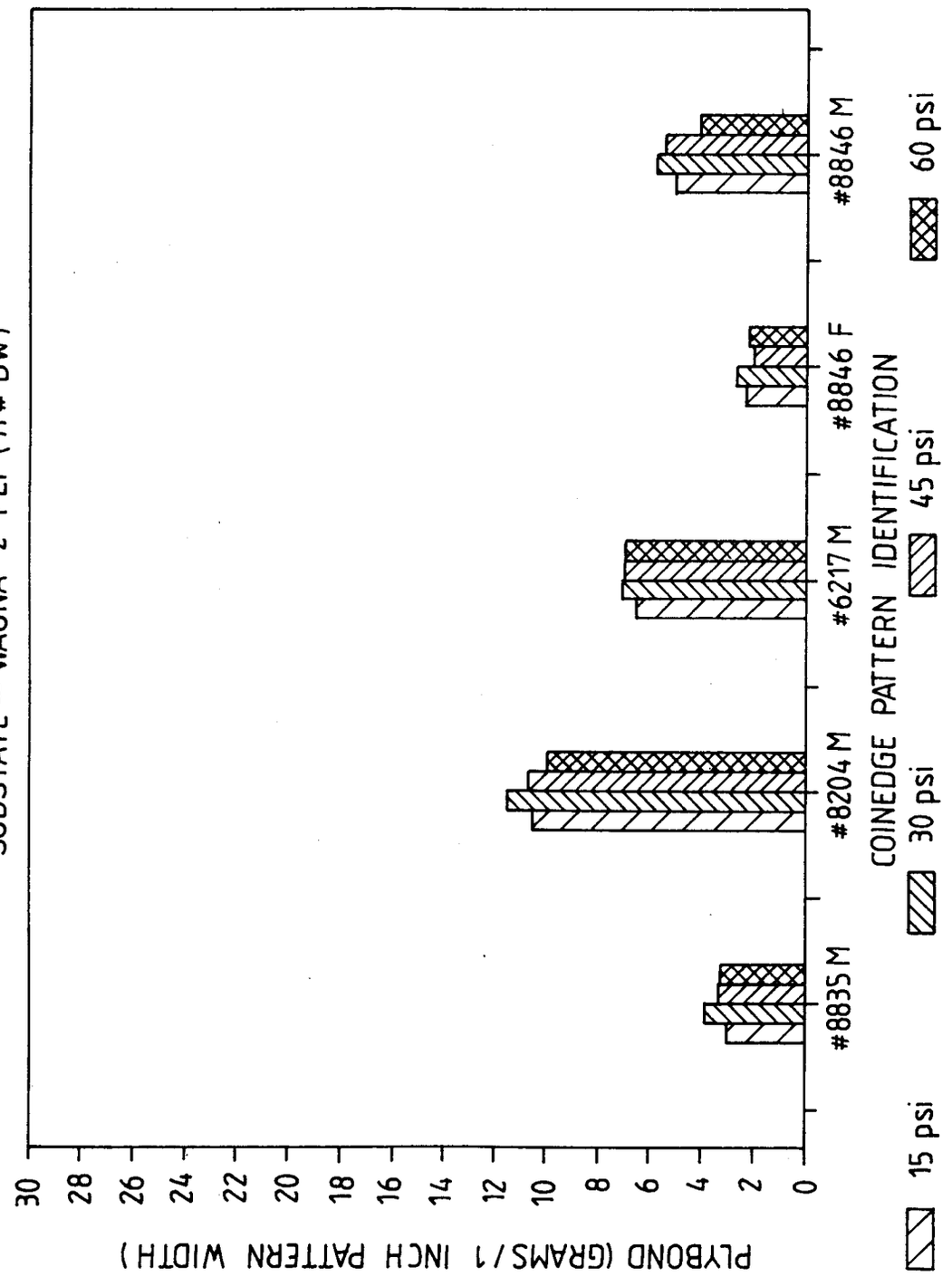
#8129 F
#6383 F
PATTERN IDENTIFICATION

Fig.13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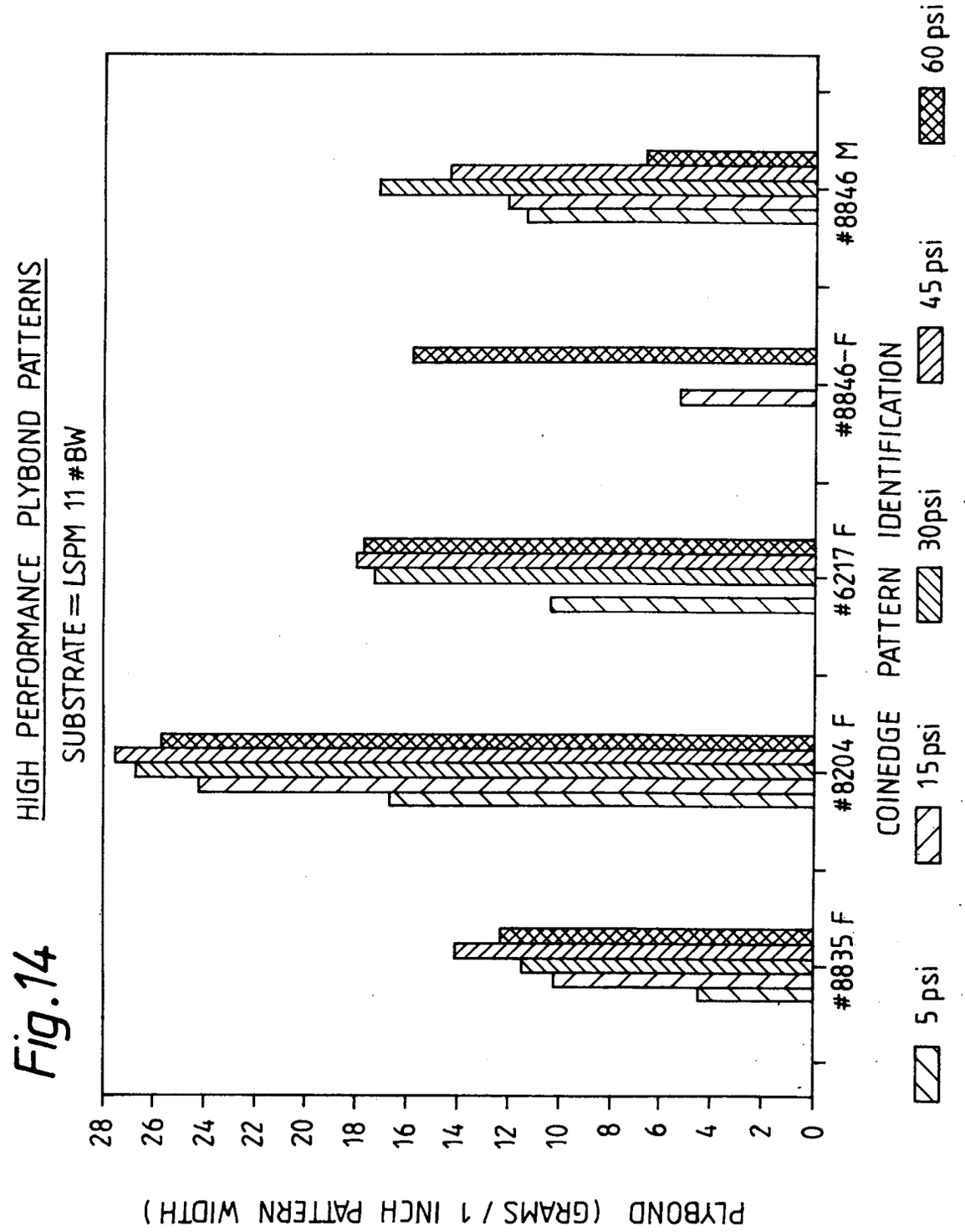
6
8
10
12
14
16
18
20
22
24
26
28
30
#8835 M
#8204 M
#6217 M
#8846 F
#8846 M
COINEDGE PATTERN IDENTIFICATION
15 psi
30 psi
45 psi
60 psi

Fig.14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18
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22
24
26
28
#8835 F
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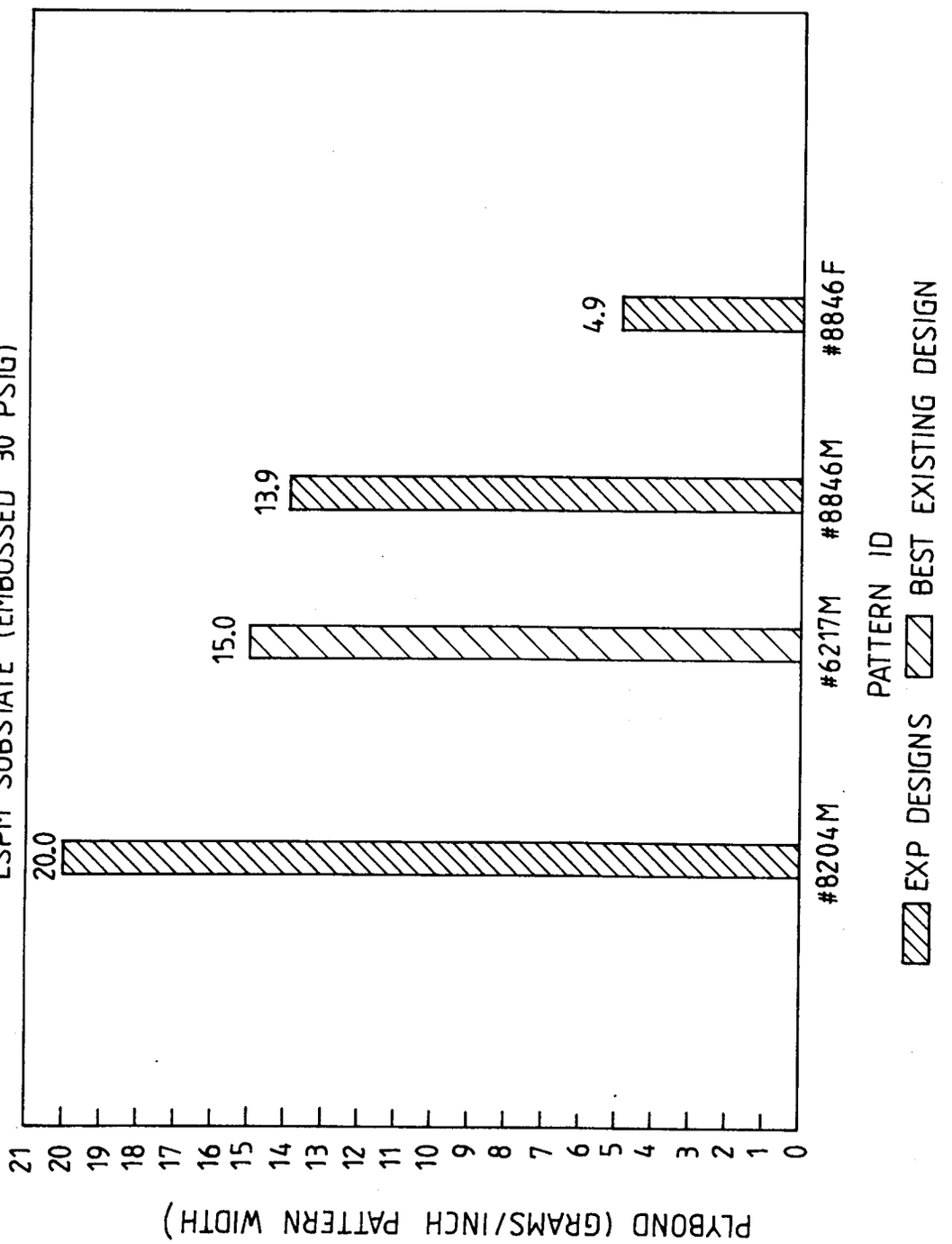
COINEDGE PATTERN IDENTIFICATION
5 psi
15 psi
30psi
45 psi
60 psi

Fig.15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LSPM SUBSTATE (EMBOSSED 30 PSIG)
PLYBOND (GRAMS/INCH PATTERN WIDTH)
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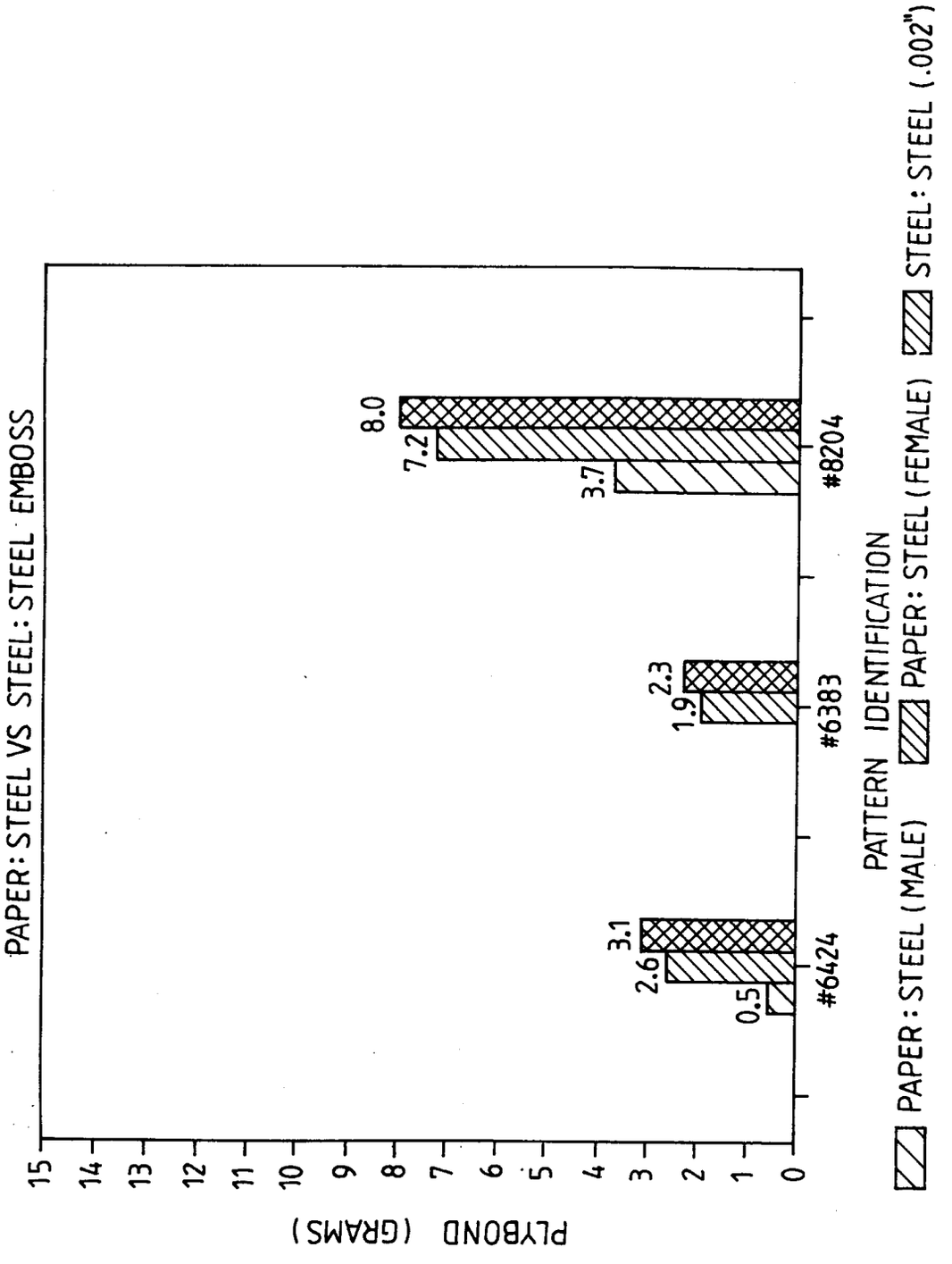
PATTERN ID
EXP DESIGNS
BEST EXISTING DESIGN

Fig. 16


PLYBOND STUDY
PAPER: STEEL VS STEEL: STEEL EMBOSS
PLYBOND (GRAMS)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
0.5
2.6
3.1
1.9
2.3
3.7
7.2
8.0
#6424
#6383
#8204
PATTERN IDENTIFICATION
PAPER: STEEL (MALE)
PAPER: STEEL (FEMALE)
STEEL: STEEL (.002")